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PORT FACILITIES IN URBAN AREAS

A THESIS

Presented to

The Faculty of the Graduate Division

by

J. Stephen Crim

In Partial Fulfillment

of the Requirements for the Degree

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




PORT FACILITIES IN URBAN AREAS

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## SUMMARY

Many port cities in the United States are involved in rehabilitating and modernizing their port's facilities. In many cases, there is an obvious lack of integration and coordination of the port's development plan with the community's comprehensive plan; in other cases, the integration seems superficial.

This thesis proposes to provide a guide for planning port facilities and insuring that they are developed as part of a comprehensive urban plan. It is intended to provide the planner, engineer or administrator with basic information on: (1) the general nature of the maritime industry (especially the unique characteristics of ships), (2) the port facilities themselves, and (3) the factors which should be taken into account in the development of the port's facilities plan.

Certain basic studies should be conducted in order to determine the port's relation to the urban area and the surrounding region before the plan can be completed. These studies provide a basic understanding of the port and its unique characteristics and problems. They also suggest methods of implementing the plan. These studies include: (1) an economic study to determine the port's competitive position and its relation to the region and the community; (2) a study of the regional, urban, and intraport transportation systems; (3) a land-use study which would inventory the port's existing land-use pattern and recommend methods of allocating land for future use; (4) engineering and site studies which provide detailed information on the site, and problems

which may be encountered in the construction of facilities; and (5) an organizational study of the jurisdictional, political, financial, personnel and legal problems encountered in implementing the plan.

Methods that might be used to insure that the port is developed efficiently and according to a plan include: (1) the promotion of port and port-related facilities, by using zoning ordinances or performance standards, establishing bulkhead lines, and by developing areas for port-related uses such as an industrial district; and (2) the discouragement and removal of uses which are unrelated to the port's operation by using Urban Renewal and other forms of eminent domain to acquire land for redevelopment by the port agency or private interests.

In order to implement the plan there must be an efficient agency capable of handling the project. The two main types of organizations are the governmental department and the public corporation, which may be a special district or a public authority. In most cases the public corporation is the more expedient type. It is widely used in the United States to develop and operate port facilities.

## CHAPTER I

### INTRODUCTION

A significant increase in port development has occurred since the end of World War II. This has been primarily due to the rapid growth and technological changes which have occurred in maritime international trade and the inability of pre-war port facilities to handle this trade efficiently. The cargo handled by the world maritime industry has expanded from 490 million metric tons in 1948 to over 1.5 billion metric tons with a value of approximately \$300 billion in 1964.<sup>1</sup>

Since the end of World War II, the United States has been the world's largest maritime nation. In 1963, U. S. ports handled approximately 340 million short tons of international cargo and over 885 million short tons of domestic, coastwise cargo. The value of this cargo and the costs of handling it amounted to over \$32 billion.<sup>2</sup> Essential commodities which the United States must import by ship include tin, chrome, manganese, and bauxite. Other important commodities include automobiles, foodstuffs, and petroleum products. The United States also exports large quantities of cargo including consumer and agriculture products, coal and phosphate.

A port may be defined as a terminal facility where the interchange between land and sea transportation occurs. For the purposes of this study, the port facilities are defined as the harbor which provides a protected place for ships and cargo transfer operations, and the cargo

handling, storage and transportation facilities on shore.

A port has significant implications for an urban area. It usually represents a significant element in the community's economy. It is also a major physical part of the city, consuming large amounts of land and creating major transportation problems. Ports are also responsible for major capital improvements expenditures. Since 1946, over \$3 billion has been spent for the improvement and construction of port facilities in the United States.<sup>3</sup>

It is the purpose of this study to clarify port related problems in urban areas and to identify factors which should be considered in planning and implementing port development. It will also attempt to clarify the port's relation to the surrounding region and city.

It is the premise of this study that the planning and development of port facilities must be included in the city or regional comprehensive planning program of a port city. It is also assumed that the development of efficient and modern port terminal facilities coordinated with the city's planning program can alleviate many urban problems. Peter Englemann, writing in the *Consulting Engineer*, described the problem.

Today, most city and regional planners face monumental problems . . . It should come as no surprise then, if the added burdens created by a complex port activity appear excessive. Nevertheless, only the solution of port problems as an integral part of the environment can prevent the ultimate strangulation of basic functions in large metropolitan areas. The close coordination of port planning with all other industrial, city, and regional planning is imperative.<sup>4</sup>

The city or regional planner who has a port within his jurisdiction has a unique opportunity to increase the effectiveness of one of the com-

munity's most important resources. It is hoped that this study will be beneficial to city and regional planners, port administrators and other public and private authorities concerned with port development.

## CHAPTER II

### MARITIME INDUSTRY AND PORT FACILITIES

This chapter is concerned with the problems associated with the location, site, and structural requirements of port facilities. The two main factors which influence these requirements include: (1) trends in the maritime industry, especially the size and character of the ships which use the port; and (2) the limitations imposed by the nature of the facilities themselves and the volume and character of the cargo they must handle.

#### Maritime Industry

The design of the port's facilities is a direct result of the requirements made by the unique characteristics of the ship and modern cargo handling techniques. Most port facilities such as wharves and transit sheds are designed to last at least 50 to 75 years. In many places, facilities still in use are well over 100 years old. The average life of a ship is about 25 years. Therefore, port facilities must be designed to accommodate two or three "generations" of ships. The flexible design of port facilities becomes especially important as technological innovations increase in the maritime industry, cargo handling, and transportation. A basic understanding of the function, size, capabilities, and limitations of ships as well as cargo handling techniques is essential before facilities can be designed.

### The Modern Cargo Ship

The cargo ship is the basic unit which determines the design standards for port facilities. Its basic limitations include its size, its extremely poor maneuverability, its requirement of deep water, its need for large amounts of frontage for berthing, its large, fixed operation costs, and its need for large volumes of cargo. In all of these limitations the ship is quite inflexible.

Ships carry either general cargo or bulk cargo. General cargo is comprised of all the various commodities which are shipped in individual packages or containers, or as individual units such as automobiles or machinery. It requires individual handling and a certain amount of care to prevent damage.

Bulk cargo is composed of loose or unpacked commodities that can be shipped in large quantities with a minimum of handling, such as grain, phosphate rock, iron ore, scrap iron and any type of liquid.

The length of a general cargo ship is usually between 450 feet for the older C2 Class vessels and 560 feet for the newer Mariner Class. Present trends indicate that general cargo vessels will not exceed about 600 feet in length. Therefore, future berth requirements for general cargo ships will be between 600 and 650 feet. Bulk cargo ships are much larger and impose special requirements on port facilities which will be discussed later.

The draft of a ship is the measurement from the surface of the water to the lowest point of the ship, the keel. The average draft of the general cargo ship is approximately 30 feet. The depth of harbors

and channels must exceed the draft of the vessel by 4 to 6 feet at low tide.

The beam is the width of the ship, usually measured at the waterline. The beam of most general cargo ships is between 60 and 75 feet. The beam of vessels using the port is an important determinant of the width of the channel and of ship berths.

Ships are also measured by weight and by volume. Measurements of ship weight include displacement tonnage and dead-weight tonnage. Displacement tonnage is the actual weight of a ship, or the weight of the water displaced by the ship. Dead-weight tonnage is the total weight of the cargo, fuel and stores which a ship is capable of carrying.

Gross tonnage and net tonnage are measurements of volume and are expressed in units of 100 cubic feet. The gross tonnage is the entire internal cubic capacity of a ship including the crew's quarters, machinery and fuel. The net tonnage is the total volume of space in the ship which can be devoted to carrying cargo. Net tonnage is important to the design of the port's storage facilities as it indicates the maximum volume of cargo which must be accommodated from a particular ship.

As an example, a small cargo ship might have a displacement tonnage of 11,500 tons. Its dead-weight tonnage would be approximately 8,000 tons. The total volume of the ship would be about 5,200 gross tons (520,000 cubic feet) and the volume of cargo space would be about 3,200 net tons (320,000 cubic feet).<sup>5</sup> Therefore, the total volume of cargo this ship could load or unload at a port would be 320,000 cubic feet.



Liquid bulk cargo ships are much larger than general cargo ships, and the trend is toward building liquid bulk cargo vessels even larger. Figure 1 illustrates the relative sizes of the various types of ships. Many liquid bulk cargo vessels are 800 feet in length with a draft of over 40 feet. Some "jumbo" tankers are over 1,000 feet in length with a draft of over 60 feet and a dead-weight tonnage of over 200,000 tons. This represents an extremely large quantity of cargo for the port facilities to handle each time one of these vessels calls at the port. Technical feasibility studies have been made on vessels with a dead weight tonnage of over 500,000 tons and a draft of over 85 feet. These vessels create major problems for the planning and design of the port's handling and storage facilities as well as the channels and ship-servicing facilities.

#### Trends in Cargo Handling

Trends in cargo handling which affect the design of the port include: (1) containerization of general cargo; and (2) increased mechanization in cargo handling.

Containerization. Recent innovations in the containerization of general cargo have significant implications for port transportation and cargo handling facilities. The trend toward the increased use of containers has been described as a "revolution."

. . . it is a revolution which will have far-reaching effects. The use of containers, if it becomes as widespread as current trends indicate, will demand a worldwide integrated transportation system and will change the very nature of the shipping industry and of the ports of the world.<sup>6</sup>

The advantages of containers include: (1) more efficient cargo

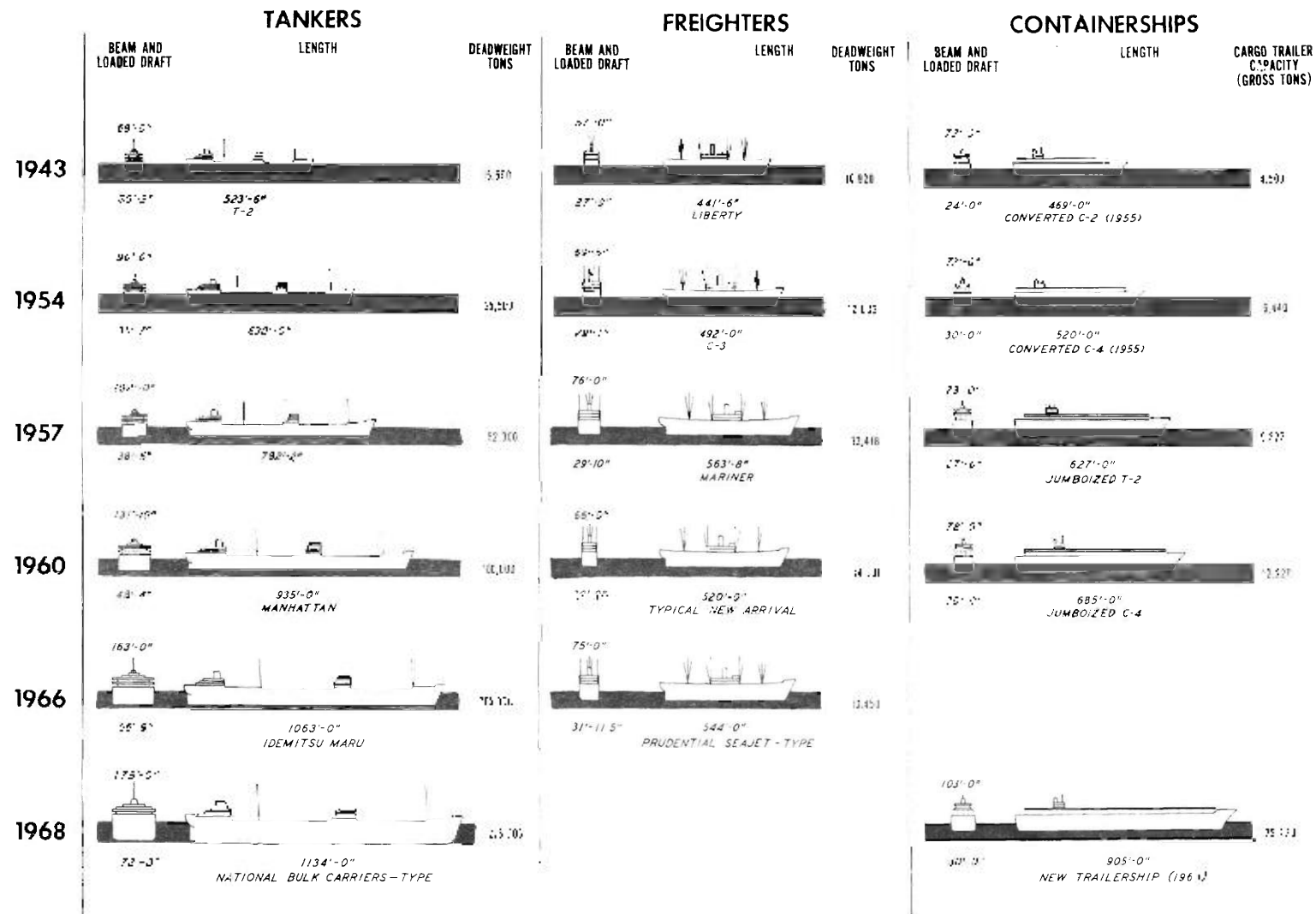


Figure 1. Increase of Vessel Dimensions and Capacities 1943-1968  
Source: "Giant Ships are Coming," *World Ports*, XXIX  
(December, 1966).

handling, (2) greater loading and unloading speed, (3) less pilferage, (4) less labor, and (5) reduced time of ships in port. The loading rate of container ships is approximately 264 tons per hour per stevedoring gang. With conventional cargo, a loading rate of 40 tons per hour would be normal.<sup>7</sup>

Although containerization is in its infancy, rapid growth is anticipated. Recent international agreements have standardized container sizes and fittings. As a result whole fleets of special container ships are being constructed to handle standard containers.

Containerization has many implications for the port's development program and transportation system. Special piers and heavy cargo-handling equipment are required to handle container shipments. Increased land requirements per ton of cargo handled require large terminal areas for the storage of containers and the assemblage of shipments. Containerization increases the flow of trucks into the port. Transportation access, especially highways and connecting local streets, as well as the intraport streets, must be adequate to handle the increased volumes of traffic that containerization will generate.

Not all ports can use containers. For example, predominantly bulk cargo ports do not use containers extensively. Where a port trades with predominantly underdeveloped countries, containers may not be feasible as highly developed transportation systems at both ends of the shipment and a reasonable two-way cargo flow are necessary.

Mechanization. The mechanization of cargo handling is an important factor in the design of facilities. Mechanical equipment has always been necessary to handle large units of general cargo, such as automo-

biles or heavy machinery. However, the use of mechanized handling equipment is becoming more important as more general cargo is containerized.

Dry, bulk cargo is usually handled by conveyor belts or by pneumatic equipment. An example of a modern, mechanized dry bulk-handling facility is the Reserve Mining Company terminal at Silver Bay on Lake Superior. Loading facilities include two belt-type boat loaders arranged to receive iron ore pellets from any one of ten belt feeders extending from five storage bins. Their rated capacity is 3,550 tons per hour, discharged directly into the ore carriers.<sup>8</sup>

The trend toward mechanization is especially significant in the handling of liquid-bulk cargo. Liquid-bulk is carried in large tanker ships which can take on or discharge cargo through a system of pipelines allowing continuous flow of the liquid with a minimum of labor. Many commodities are shipped in liquid form which greatly reduces their handling costs. These include sulfur, food oils, latex, wine, and even slurry iron ore. An example of a liquid-bulk handling facility is a molasses handling and processing terminal at Baltimore. Molasses is discharged from the ship into a pipeline running 2,600 feet from the berth to the tank storage area which includes two 2,000,000-gallon storage tanks and two 170,000-gallon mixing tanks.<sup>9</sup>

#### Port Facilities

Port facilities may include: (1) a harbor; (2) off-shore facilities; (3) water front structures; (4) inland storage areas; and (5) transportation facilities essential to the port's cargo-handling

operations. The location, type and size of the various facilities vary with individual port situations.

The design and structural problems associated with the development of port facilities are primarily an engineering responsibility. However, a basic understanding of the facilities, their functions and their relation to each other, is an essential prerequisite to the formulation of a comprehensive port facilities plan.

#### Harbor

A harbor is a place where ships can find protection from the sea in order to transfer cargo. It may be a large protected bay with many different port facilities located on it such as New York Harbor or San Francisco Bay, or it may simply be a place along a river's bank where ships can berth, as in Jacksonville.

The harbor should be large enough to provide anchorage for vessels waiting for a berth, and it should have a turning basin where vessels can turn around, unaided by tugboats. In some cases a harbor may be large enough to provide testing ranges for the testing and adjustment of ship's equipment, such as radar or compass.

The harbor may be natural or man-made. Man-made harbors are created by constructing breakwaters around the area of water which is to be protected. Breakwaters are usually constructed from large rocks, precast concrete, steel, timber, or even sunken ships, and are generally placed at right angles to the severe wave direction. They are also often used to augment natural harbors. Figure 2 illustrates an example of a harbor created by breakwaters.

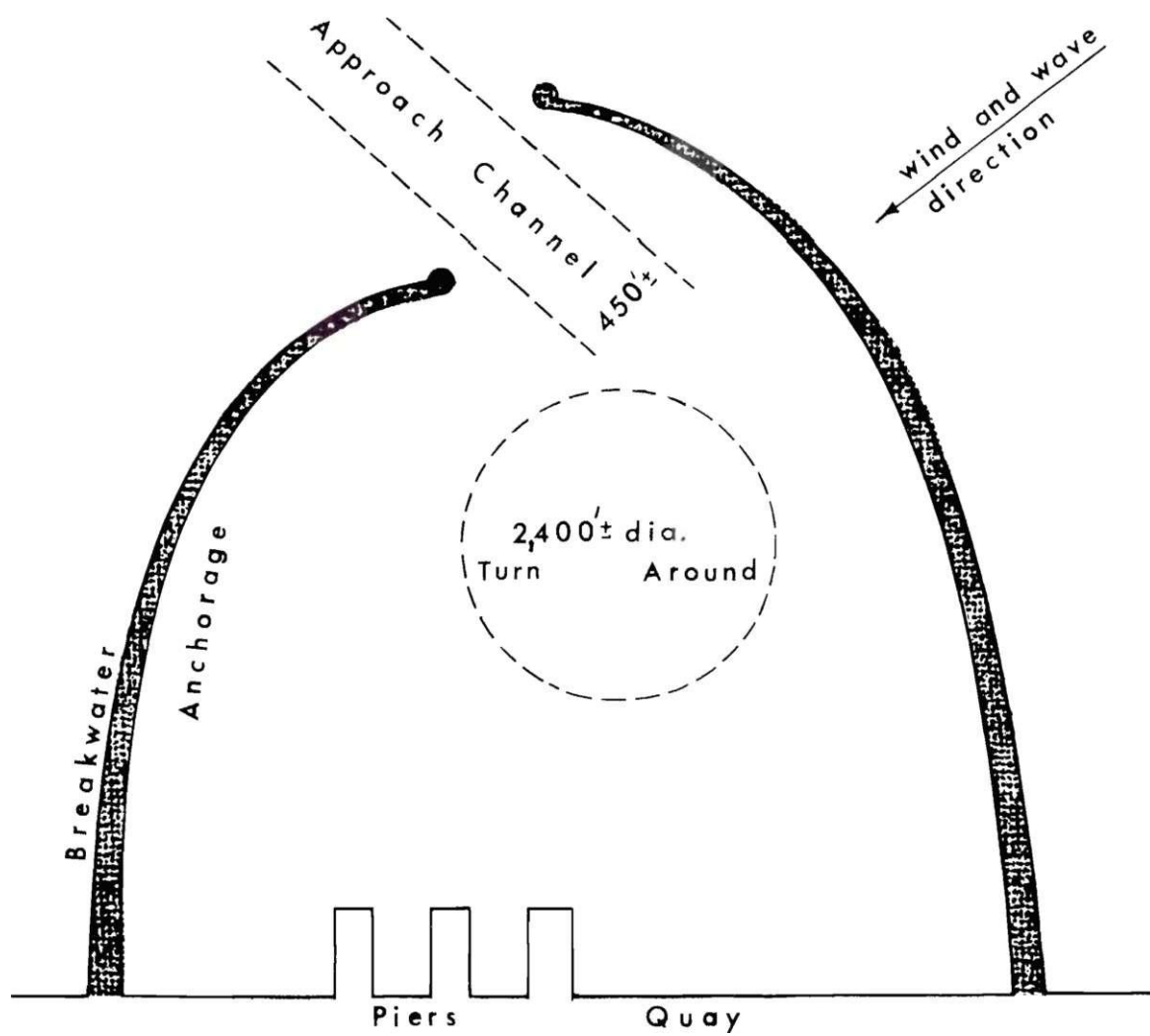


Figure 2. Harbor Created by a Breakwater

Many ports require approach channels to provide access from the open sea to the harbor. Channels may also be used within the harbor to provide access for deep-draft vessels to the various port facilities. From the surface, the only indications of the channel may be marker buoys which delineate the limits of deep water. The approach channel may be a river or man-made. Examples of seaports which utilize a river for access are New York, Philadelphia, Savannah, Jacksonville, and New Orleans. Houston and Sacramento are examples of ports which utilize man-made channels for access to open water.

Almost all channels require dredging to make them deep enough to allow large, sea-going vessels with deep drafts to enter the harbor. Many channels require continual dredging to maintain the required depth. This is especially true of river channels which collect silt. The mouth or opening of the channel often requires dredging to prevent shoaling caused by ocean currents and from silt carried down the channel.

Channels in the United States are generally between 32 and 40 feet deep. This depth is adequate for most cargo vessels. However, the new larger, bulk cargo carriers require depths of more than 65 feet. In many cases substrata soil conditions below 40 feet are such that the cost of deep dredging is prohibitive. Under these conditions, alternative solutions, such as off-shore cargo-handling stations, are employed.

#### Off-Shore Facilities

Off-shore loading stations provide cargo handling facilities for large ships which cannot enter the channel or harbor. These facilities usually handle bulk commodities and are connected to storage and

processing facilities ashore by pipelines or conveyor belts. In many cases these off-shore loading stations eliminate the need for more expensive channel dredging. A recent study of the feasibility of constructing an off-shore loading facility, 25 miles south of Sydney, Australia, at Coal Cliff, illustrates the characteristics of this type of facility.

It was planned to export 1,000,000 tons of coal and coke annually for Japanese markets. Because there is no protected harbor at Coal Cliff, coal is shipped by rail to Port Kembla, some 18 miles to the south, for export. For comparative purposes, it was desired to establish whether direct ocean shipment of the coal could be made for Coal Cliff. The shore topography consists of steep cliffs and beaches, and this feature, together with the prevailing rough seas makes a conventional type wharf impractical.

The study established the feasibility of constructing a loading platform approximately 2,000 ft. offshore, at which vessels of 50,000 deadweight tons could berth. [See Figure 3.] A suspension bridge was planned to carry a 3,000 ft. belt conveyor from shore to a loading tower on the platform. An economic study indicated that for the narrow width required and considering the number of necessary foundation structures, a suspension-type bridge would be least expensive to erect at the site. By restraining the vessel from impinging on the loading structure, it was anticipated that waves or swells could reach a height of 6 ft. to 8 ft. before it would become necessary to remove moored vessels. By comparison, a vessel moored alongside a conventional type wharf would be subjected to considerable hazard under the influence of waves and swells in excess of 3 ft.<sup>10</sup>

The demand for off-shore facilities is expected to increase as more large bulk carriers are put in service.

#### Water Front Structures

A port's primary structures are the wharves which provide space for ship servicing and loading, and the transit sheds where cargo is stored and sorted immediately prior to loading.

Wharves. A wharf is a structure or platform to which a ship is



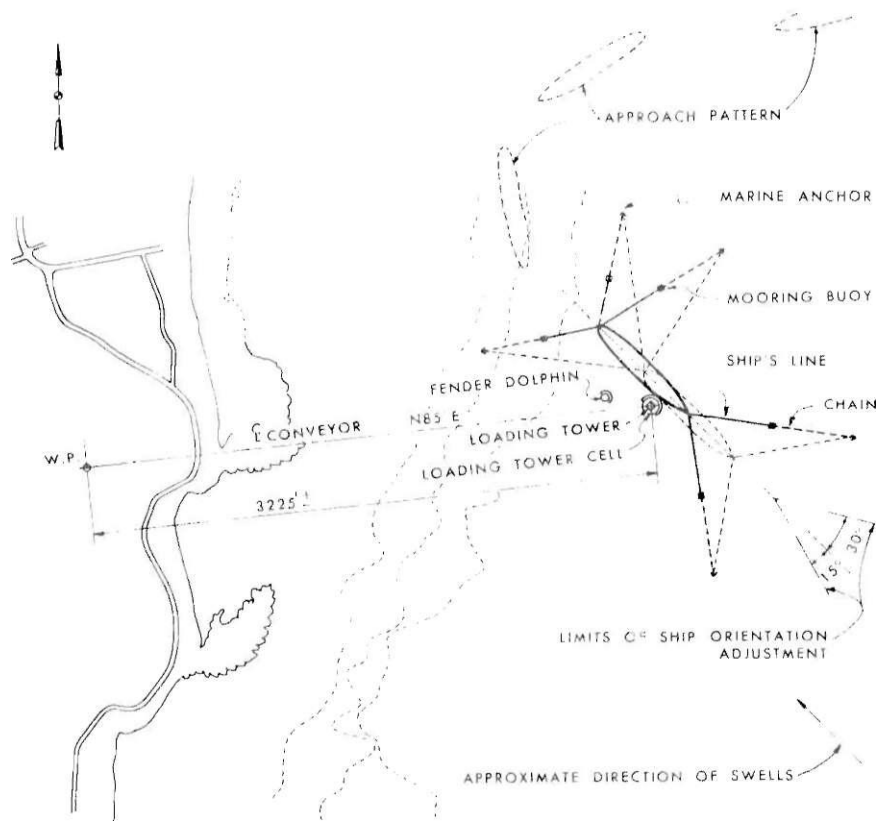


Figure 3. Proposed Off-Shore Terminal Facility  
 Source: *Journal of the Waterways  
 and Harbors Division Proceedings  
 of the American Society of Civil  
 Engineers*, XCI (May, 1965).

moored. The water side is the ship's berth, and the land side is the cargo-handling apron.

Piers and quays are the two basic types of wharves. A pier, sometimes referred to as a finger pier, is constructed approximately perpendicular to the shore. A quay is constructed parallel to the shore and is sometimes referred to as a marginal wharf.

The main advantage of the pier is that it can handle more ships per given length of water front. A pier frequently can accommodate ships on two or three sides (Figure 4). The disadvantages of the pier include: (1) the collection of silt between piers necessitating frequent dredging, (2) congested transportation service to the pier, and (3) inefficiency in the cargo-handling operations on the pier.

The main advantages of the quay are: (1) the inland transportation system can serve the wharves more easily, (2) the lengths of berths are flexible, (3) ships can maneuver into a berth easily, (4) berths are less congested, and (5) the size of transit sheds and aprons can be larger and more efficient than the ones located on a pier.

Berths. A berth is the space along a wharf in which a ship is tied or moored. The berth's main dimensions are length along the wharf and depth of water. The length generally will be about 620 feet. This is the length of a Mariner Class, or typical cargo ship which is 560 feet, plus 60 feet for maneuvering space. The depth of the berthing space should be adequate to accommodate the draft of any vessel which might call at the port. In some ports, tidal fluctuations are so great that docks must be constructed with gates to provide deep water for

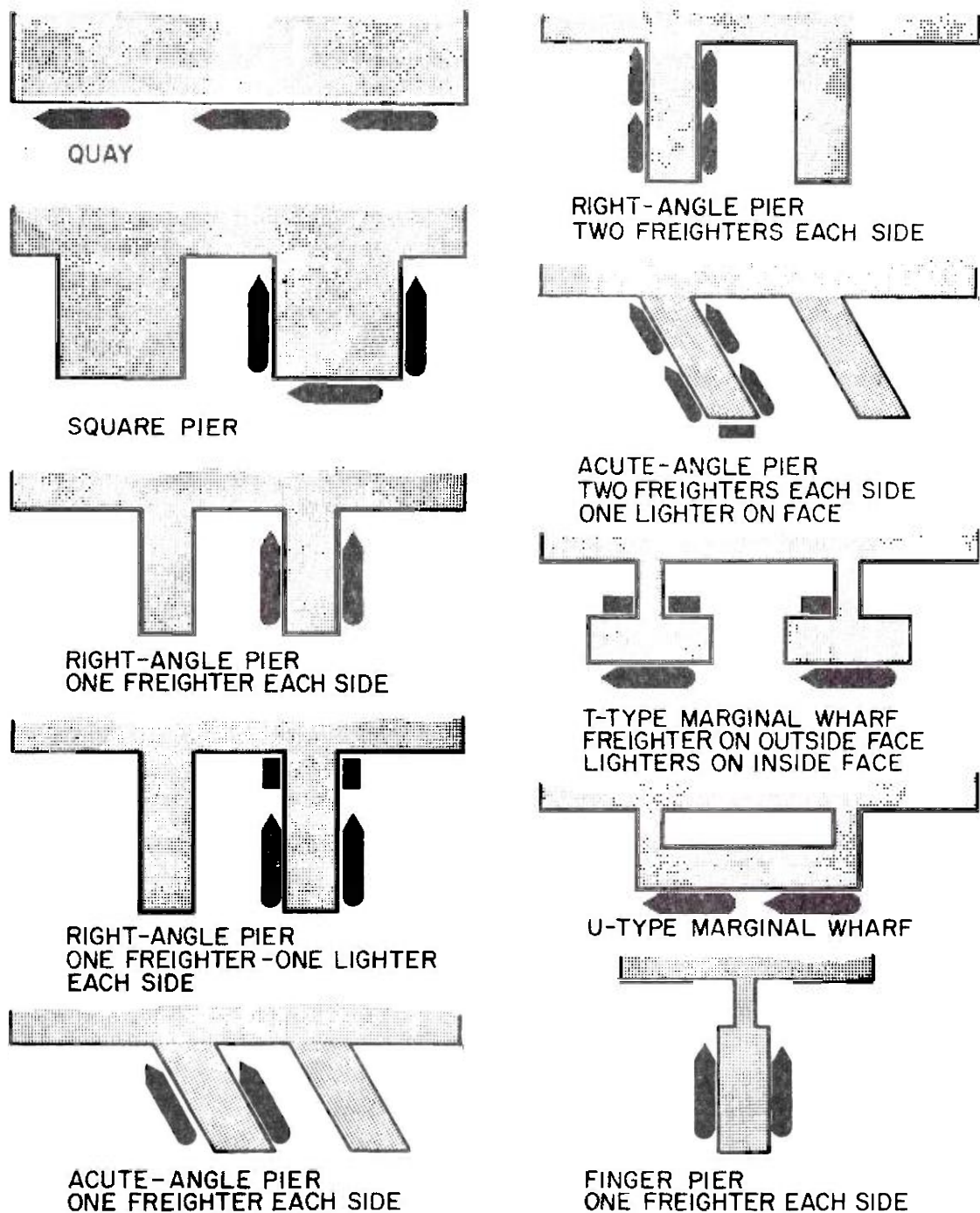


Figure 4. Wharf Types

Source: U. S. Army Transportation School,  
*Port Capacity Estimation, Reference*  
 Text 243 (Fort Eustis, Virginia:  
 January, 1965).

ships' berths during low tides. Docks are very common in European ports.

The width of the berth is determined by the beams of the vessels using the berth. The average cargo ship has a beam of from 65 feet to 80 feet. It is important that berthed ships remain clear of channel traffic in ports with narrow channels. In planning finger piers, care should be taken to insure that there is adequate space for at least two or more vessels in the spaces between the piers.

A berth may also contain bunkering facilities to fuel and service ships. Efficient design provides bunkering facilities which can serve the ship simultaneously with the cargo-handling operations in order to decrease the ship's time in port.

Aprons. An apron is that part of a wharf that is immediately adjacent to the berth. It is the focal point or work area for the transfer between the ship and the port's facilities. The apron is frequently used for the temporary storage of cargo and equipment which does not need protection from the weather.

The apron should be wide enough to accommodate the transfer of cargo including the inland transportation modes which might bring cargo directly to the ship and the cargo-handling equipment, such as heavy cranes. However, the apron should not be wider than necessary. The further the cargo must be transported to transit and storage sheds, the higher the cost of cargo handling. Most modern aprons are 80 to 100 feet in width.

Transit Sheds. A transit shed is usually on the wharf or immediately adjacent to it, opposite the berths. The function of the transit

shed is to provide short term, covered storage for cargo in transit. When a ship arrives at a port, it must discharge its cargo and reload new cargo as quickly as possible. It cannot afford to wait for the off-loaded cargo to be sorted and moved inland. The transit shed provides a protected place for the discharged cargo to be stored until it can be sorted according to consignee and moved inland.

A transit shed also provides a place for cargo to be organized for loading aboard ship. The loading of a ship's cargo hold is a very complex process. It is complicated by the fact that the cargo usually does not all go to the same destination and by the relative weights of the various commodities as they relate to the ship's center of gravity. A loading plan must be carefully prepared before the ship arrives in port. The cargo is sorted in the transit shed, according to commodity and destination, in order of its designated place in the ship's hold. This advanced preparation of the cargo minimizes congestion and confusion during the loading operations. The transit shed is usually a simple structure, frequently without sides or walls. This open-type shed maximizes the movement into the shed, increasing the shed's flexibility and reducing congestion.

The transit shed can be a complicated structure. In heavily congested ports where land is scarce, transit sheds may be two-story structures and combine transit storage of cargo with longer term storage, passenger terminal operations, and port office operations. This type of structure is common in European ports and in the larger ports which serve passenger traffic in the United States. At some ports the transit sheds are designed to accommodate special commodities, such

as coffee, fruit or automobiles.

Generally, the transit shed should be large enough to accommodate at least one full load of cargo from a modern ship. A minimum of 90,000 square feet per berth is considered desirable.<sup>11</sup> This figure is based on the amount of cargo an average ship can discharge and load at the port, plus the necessary space inside the transit shed for the easy movement of cargo by forklifts. The transit shed should be designed for flexibility in order to accommodate as many cargo handling situations as possible and to adapt to future requirements which may be imposed upon it.

#### Inland Storage Facilities

Inland storage facilities supplement the short-term storage of the transit shed and compensate for seasonal and traffic fluctuations. Where production of commodities, such as cotton, wool, coffee, sugar and grains, varies by seasons, storage facilities are necessary for their accumulation. Inland storage is also necessary when there are delays due to erratic shipment schedules or complications arising from legal difficulties, such as litigation or customs requirements. Long-term storage seldom exceeds one year, except in special litigation cases. Inland storage facilities include:

1. open areas for the storage of non-damageable commodities, such as dry bulk commodities, automobiles, or container units, as well as areas for storage of cargo inside transportation vehicles,
2. protected storage facilities including public or private warehouses, free ports, and bonded warehouses for the protected longer term storage of commodities,

3. special storage facilities include cold storage for handling perishable commodities, and facilities for handling bulk and dangerous commodities, such as petroleum products, molten sulfur and explosives.

Open Storage Areas. Open storage areas are provided in the port vicinity. These areas need only a minimum of site preparation, depending on the commodity to be handled. If the area is to be used for the stockpiling of dry bulk cargo, such as coal, gravel or lumber, the site needs no preparation. However, if it is to accommodate more valuable commodities, such as automobiles, it should be graded and preferably paved or planted in grass.

The storage of cargo inside the transportation vehicle is being increasingly used to reduce handling costs. Cargo is left inside the vehicle until it is needed at the wharf. This reduces the amount of handling necessary for each commodity, but it increases the required open storage space.

The storage of container units is an example of a special open storage area. Basically, its requirements are the same as other vehicle storage areas. However, due to the special nature of container operations, a special facility is needed. The container storage area should be paved and have direct connection to highway and rail connections. It should also have special equipment for handling the container units. This equipment may include trucks, heavy-duty forklift trucks, and straddle carriers. The facility should also have provisions for assembling and receiving cargo for containerization. In some cases electric service for refrigerated containers will be required.

The space requirements for open storage facilities vary according to the commodities they must handle. Dry bulk commodities can be stockpiled and, therefore, do not require as much space as a commodity which must be handled carefully, such as an automobile. Generally, it is recommended that between 100,000 and 200,000 square feet of open storage areas be provided for each berth in the port.<sup>12</sup>

There are no formal specifications for the amount of land which should be set aside for the storage of transportation vehicles. However, experience has shown that at least the equivalent of one ship load of cargo should be provided for every two or three berths.<sup>13</sup> A ship load is approximately equivalent to over 200 railroad cars or over 500 truck trailers. These vehicular storage areas can be located close to the wharves or at a substantial distance from the port area as is appropriate. The storage of the rail cars may even be accommodated in marshalling and rail storage yards in other parts of the city. Truck trailers can also be stored outside the port area in truck terminals.

Protected Storage. The warehouse is the most common type of protected storage facility found in ports. It can be a large, elaborate, multi-storied structure offering many different services, or it can be a simple, open storage shed.

Two main types of warehouse operations are the storage of commodities in transit awaiting consignment and the storage of commodities for merchandising, involving a high inventory turnover. The first type is concerned with long-term storage and may be highly specialized, such as cold storage warehouses, granaries and customs storage. Merchandising warehousing is more concerned with wholesaling and limited



processing operations. It generates more traffic than other types of warehousing and is frequently associated with industrial and free port operations.

A free port, sometimes referred to as a foreign-trade zone in the United States, is an area set aside within the port area which is exempt from customs regulations. It is usually separated from the rest of the port by a fence, guarded by customs officials. Richard S. Thomas has described the function of the free port.

. . . Foreign merchandise brought into this zone may be stored and exchanged (the latter almost invariably on a wholesale basis), and may or may not be manipulated, exhibited, or manufactured (depending upon local regulations). In any case it may be re-exported without having been subject to tariffs of the host nation.<sup>14</sup>

The free port is most economical when it is used in a highly industrialized, tariff-enclosed nation, when it is a relatively large scale operation, and when most of the merchandise handled is ultimately imported into the host nation.<sup>15</sup> The use of free ports has not been too successful in the United States. This is primarily due to two factors: (1) they have not been large-scale operations; and (2) the advent of the bonded warehouse has made the free port concept somewhat obsolete.<sup>16</sup>

A bonded warehouse serves the same function as the free port. However, it can economically operate on a much smaller scale. It stores commodities, tariff free and under bond to the government of the host country, until the merchandise is consigned to specific destinations. The customs duty is not paid until the merchandise is shipped to consignees within the host country. If the merchandise is re-exported to other countries, no tariff is collected. Bonded warehouses are often

used where high tariffs are imposed on luxury items, such as liquor.

Special Storage Facilities. Special storage facilities include cold storage, liquid bulk storage, and storage of dangerous cargoes. Cold storage is essential where perishable cargoes are involved, such as fruit or meat. Storage facilities for dangerous cargoes are usually located away from the main port operations and the urban area. Examples of such facilities are the chemical storage tanks in Texas City, Texas, liquid sulfur storage tanks in Tampa, Florida, and the munitions depot at Sunnypoint, North Carolina. These facilities may be in the form of warehouses, vehicle storage areas, open storage, or liquid tank storage, and are frequently associated with industrial operations.

#### Transportation Facilities

The port's primary transportation facilities are railroads, streets and parking, and, in some cases, waterways. The port's versatility increases as more transportation modes are used, but the chances for congestion also increase.

Rail. The port's rail facilities consist of lead tracks to the wharves and along the water front, team-tracks which serve the transit sheds, warehouses, and other storage facilities, and frequently a small classification yard.

Lead tracks along the waterfront and to the individual wharves are frequently in pairs with many crossovers to allow for efficient switching. The tracks closest to the water or ship are usually used for loading while the other tracks are kept open for movement.

Streets and Parking. The port's street system is comprised of the major thoroughfares which connect the port with the city and local

streets which serve the various port facilities. These streets must accommodate large volumes of truck and automobile traffic. In some cases a major thoroughfare along the waterfront is used in a manner much like a belt-line railroad in order to provide efficient vehicular access directly to the wharves. Many ports provide off-street parking at the various facilities for trucks waiting to load or unload. This greatly reduces congestion and facilitates efficient cargo handling. A new cargo terminal at the Port of New York can permit 90 trucks to load at transit shed platforms and 110 vehicles to park in a special "truck court" without interfering with other traffic.<sup>17</sup>

Waterways. Intraport waterways, or canals, are used more extensively in Europe, where inland waterways and barge traffic are much more prevalent, than in the United States. The main advantage of waterways is the reduction of cargo handling and transfer as they provide direct access to warehouses and other storage facilities. However, where waterways are used, they create conflicts with the other transportation modes in the port.

#### Modern Terminal Facilities

The following examples of modern port terminals are presented to illustrate the flexibility of terminals and the relationships between their various components.

Jacksonville, Florida. Prior to rehabilitation, the Port of Jacksonville's facilities consisted of three dilapidated piers with inadequate transit sheds and inland storage facilities (Figure 5). Silting between piers required frequent dredging.

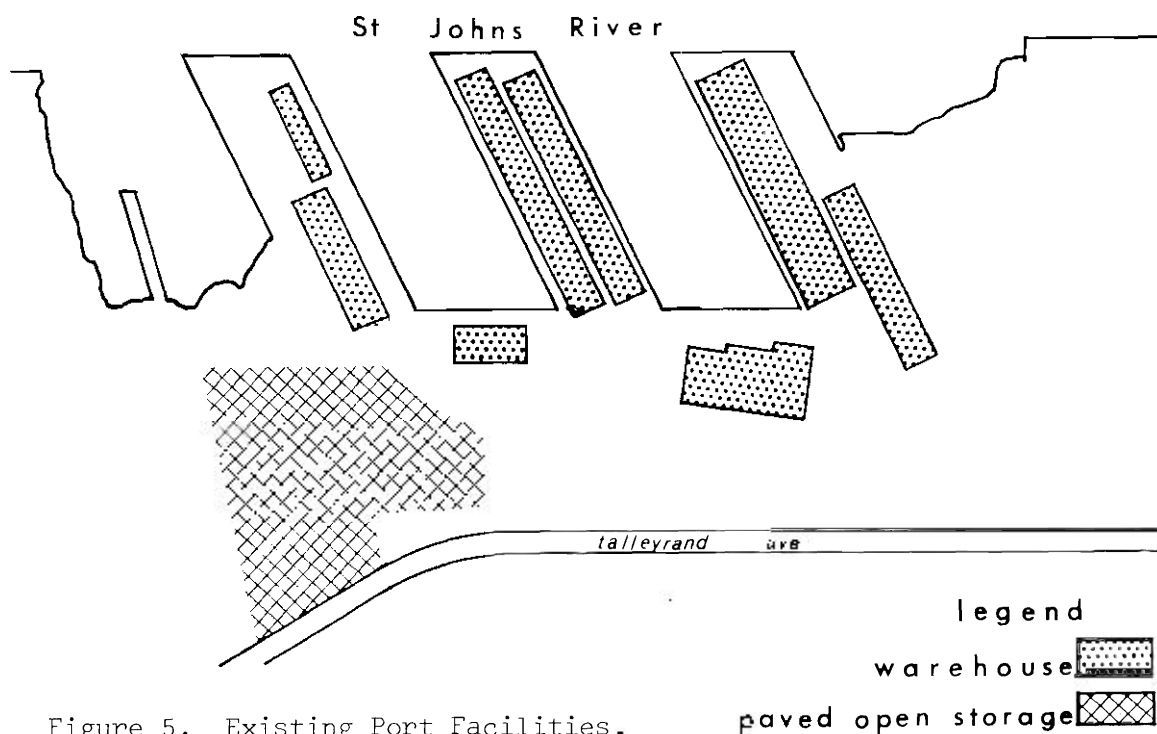


Figure 5. Existing Port Facilities,  
Port of Jacksonville

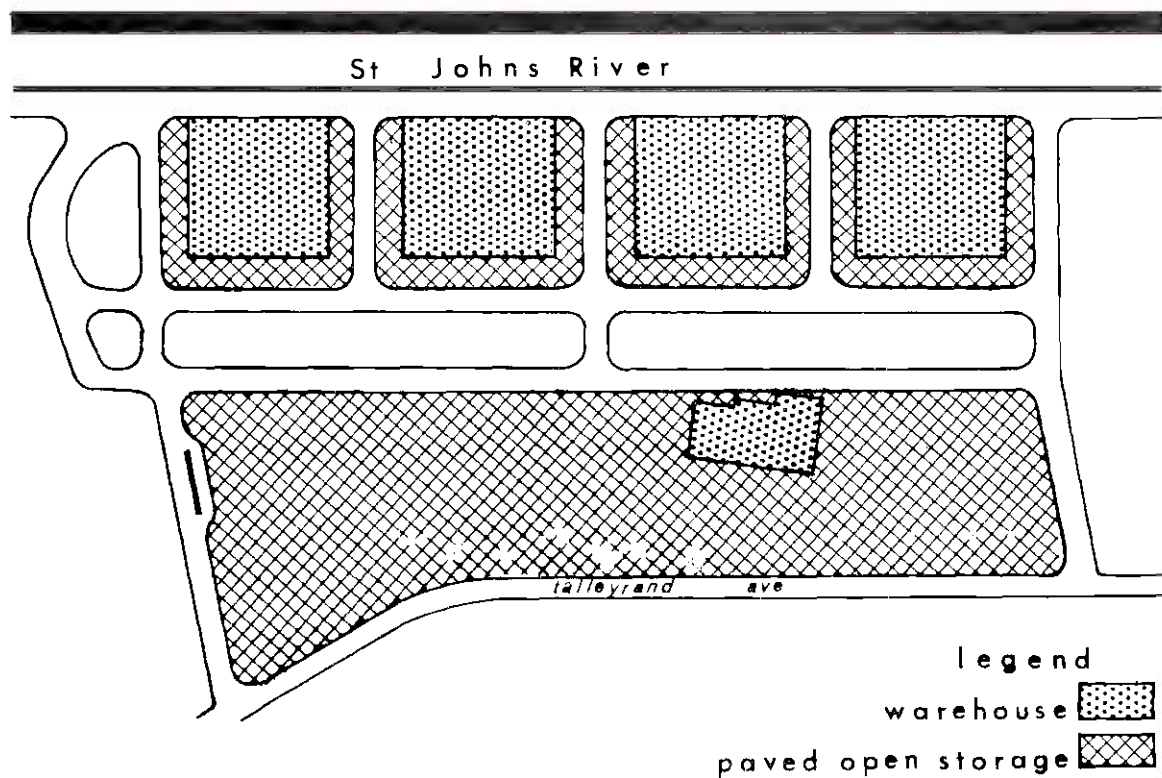


Figure 6. Proposed Port Facilities,  
Port of Jacksonville

The Jacksonville Port Plan proposes to replace existing piers with a quay (Figure 6). A bulkhead is to be constructed across the end of the existing piers and the space between them filled. The quay was chosen in order to accommodate inland transportation facilities more easily. It also provides larger, more flexible transit sheds and more inland surface area for open storage. The new facility will have an 80-foot apron and double-lead railroad tracks running the entire length of the wharf.

The most unique feature of the plan is the construction of four "modular transit shed-warehouse" (Figure 7). The 600-foot module is based on the average berth length. In the center of each module is a 400-foot square, combination transit shed-warehouse. Each structure contains 160,000 square feet of covered storage and has three main sections. The 1/3 nearest the apron is for movement to and from ships. The center 1/3 is for short-term storage of cargo in transit. The rear 1/3 is for the longer term storage of cargo. These structures are designed for maximum flexibility and utilization of space.

The proposed Jacksonville Port development is one solution to providing modern, flexible, terminal facilities where existing facilities are inadequate.

Miami, Florida. The new Port of Miami terminal is a man-made, 275-acre island in Biscayne Bay located five miles from the open sea. It is approximately rectangular in shape and has a continuous quay capable of accommodating approximately 14 ships at one time.

Terminal facilities include two 200,000 square foot transit sheds and two 36,000 square foot transit sheds. The interior of the island

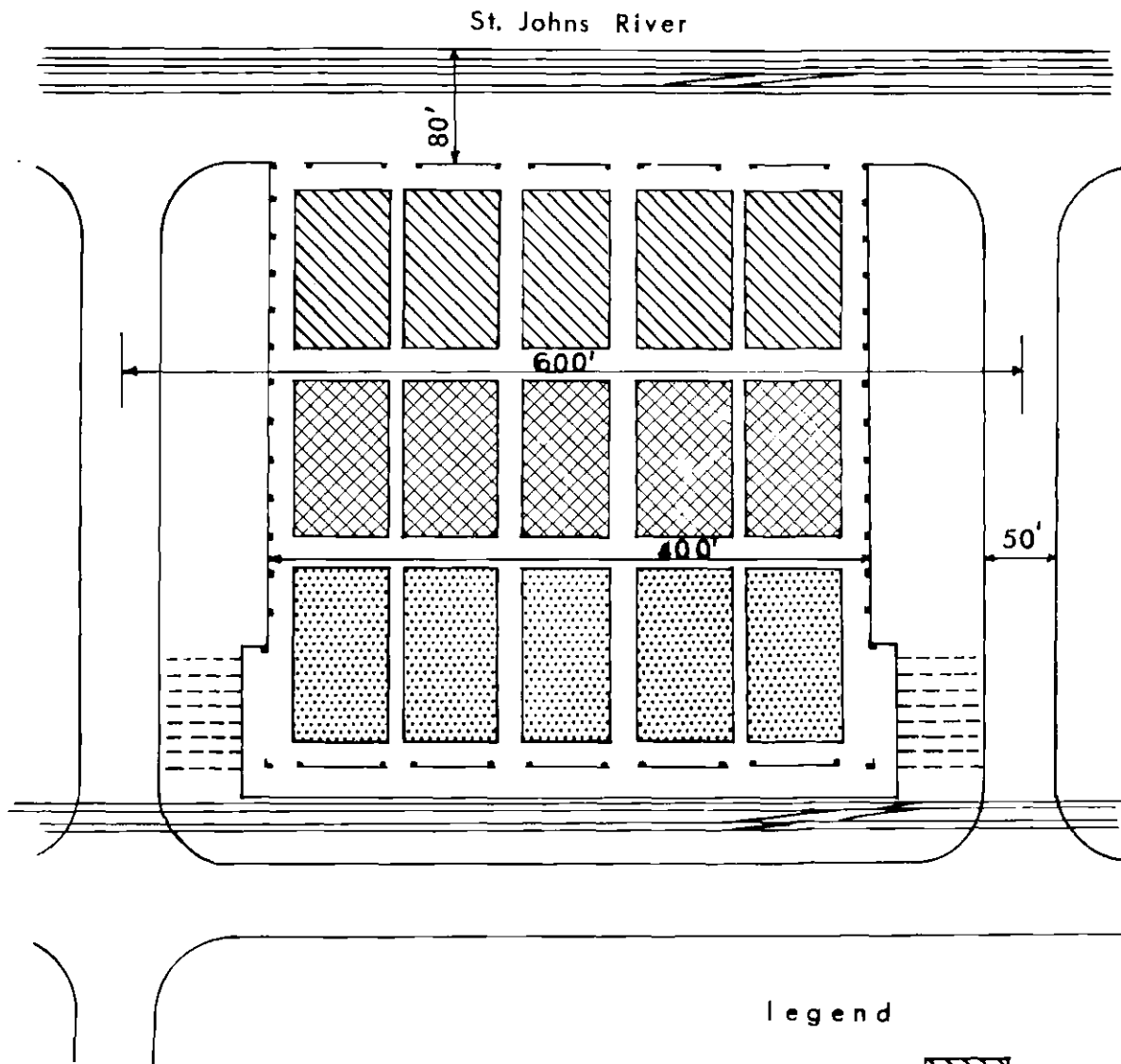


Figure 7. Jacksonville Transit Shed-Warehouse

can be used for open storage and future development.

Norfolk, Virginia. A recently constructed terminal facility at Lamberts Point, in Norfolk, uses piers. This modern pier development contains a variety of facilities.

Pier N at Lamberts Point in Norfolk, Virginia, is the largest single-deck merchandise pier on the Atlantic seaboard. A description may be useful. Pier N can simultaneously accommodate four large oceangoing freighters. Water depth is 35 ft at mean low tide. The pier shed, 320 ft wide and 1050 ft long, contains sufficient floor space to lay out the entire cargoes of the four ships. Pier N is served by six tracks, two depressed tracks extending through the center of the pier shed and four tracks located on two separate two-track 35 ft aprons. Cars on tracks can be loaded or unloaded directly from or into ships. Two large warehouses, each 108 ft wide and 1000 ft long, are connected with the pier by a covered runway.

Two other piers, five additional warehouses, and extensive ground storage space are included in the Lamberts Point terminal facility. One pier has overhead pipelines for transferring animal, fish and vegetable oils from tank cars to ships. Steel storage tanks with a capacity of over two million gallons are adjacent to this pier. A four chamber fumigation plant is included in the terminal facilities. This plant is used to fumigate such commodities as cotton, cotton waste and tobacco.<sup>18</sup>

## CHAPTER III

### PLANNING STUDIES

Before a plan for the development of port facilities can be completed, certain studies should be conducted in order to gain an understanding of the port's relation to the region and the city. These studies identify trends and problems which affect the port's development. They should include: (1) an economic investigation of the port's hinterland and the city it serves; (2) a study of the regional, urban and intraport transportation systems; (3) a land-use study of the port; (4) various engineering and site studies; and (5) organizational studies which should indicate the problems of implementing the plan.

#### Economic Studies

In order to determine the economic importance of a port, its competitive position, its hinterland, and its impact on the community should be evaluated.

#### Competitive Position

Most ports compete fiercely for trade. This is especially true of ports in a position to compete with each other for a particular hinterland's trade.

Before a plan for the development of a port's facilities can be formulated, a study of the port's competitive position should be made to determine its relative importance and its growth potential. This study should identify and evaluate the competition offered by



other ports. It should analyze the port's advantages and the possibility of increasing these advantages. The port's potential to increase its competitive position will determine the need for improved port facilities.

Major developments affecting the port's competitive position should be investigated and evaluated. An example of such a development is the Cross Florida Barge Canal which is expected to have a tremendous impact on the Port of Jacksonville's competitive position. It will connect the Port of Jacksonville on the Atlantic Coast with the Gulf of Mexico reducing the time presently required to transport cargo around the Florida peninsula by three days. Tonnage through the port is expected to increase from below 10 million tons per year to over 32 million tons per year.<sup>19</sup>

Any other developments which might have an effect on a port's competitive position, such as a change in the labor force, industrial activity, or a discovery of an important natural resource, should be evaluated in terms of the effect these changes would have on the port's growth potential.

Good geographic location, efficient facilities, and good ancillary services are the main qualities that strengthen the competitive position of a port. The Port of New York on the Atlantic Coast, New Orleans on the Gulf Coast, and San Francisco on the Pacific Coast, combine these qualities with an established reputation, placing them in an exceptionally good competitive position.

There are two types of factors which affect the port's competitive position: (1) those which cannot be changed or significantly

altered, such as geographic location; and (2) those which can be improved to enhance the port's competitive position, such as the quality of facilities, port costs and the quality of ancillary services.

Geographic Location. The geographic location of a port cannot be changed. Factors which are important in geographic location are the port's relationship to ocean shipping lanes, its distance from the sea, and its distance from inland markets.

An example of a port whose geographic location has enhanced its competitive position is the Port of New York. Its location on the Atlantic Coast relative to other ports has a substantial advantage. New York has an excellent harbor with easy access to the sea. Other ports competing with New York, such as Philadelphia, located inland on the Delaware River, do not have such easy access to the sea. New York's location with respect to Atlantic shipping lanes is also an important advantage. It is the first port of call for ships coming from Europe and the last port of call for ships leaving the United States bound for Europe.

Climatic conditions which are a result of geographic location can affect the port's operation. For example, ports on the St. Lawrence Seaway are closed during the winter months due to ice. During these months, cargo destined for their hinterland must be handled by ports to the south, such as St. Johns, New Brunswick, Boston or New York. This places the St. Lawrence Seaway ports at a distinct disadvantage.

Port Facilities. The quality of the port's facilities directly affects the efficiency of cargo handling and the costs of shipping through a port. The port with the most modern and efficient facilities

will have an advantage over ports with obsolete facilities and equipment.

The Port of New York has the widest range of facilities of the Atlantic Coast. New York exports commodities which originate in Florida even though these commodities must pass through the Ports of Baltimore and Philadelphia to get to New York.<sup>20</sup> In this particular case, New York's advantage is the fact that it has a choice of specialized facilities to handle and store unique cargoes.

The costs incurred in handling cargo in the port can significantly affect the port's competitive position. Modern and efficient port facilities can reduce these costs.

In 1964, an extensive survey of five major North Atlantic ports compared their various costs of handling a ton of cargo, assuming that an average shipment handled a minimum of 500 tons. Table 1, on the following page, illustrates this comparison.

Stevedoring and the other forms of labor represent the largest single port cost. The modernization of the port's facilities can reduce labor costs by increasing labor efficiency.

Ancillary Services. Examples of ancillary services which increase a port's efficiency and its competitive position are international banking, consular representatives, freight forwarders, and steamship lines and agents. In New York there are 12 banks with 178 foreign branches, 76 foreign consulates, 492 freight forwarders and 476 steamship lines. By contrast, Philadelphia, a competing port, has two banks with four overseas branches, 33 foreign consulates, 29 freight forwarders, and 136 steamship lines.

Table 1. Port Costs per Ton of Cargo

	Boston	New York	Philadelphia	Baltimore	Hampton Roads
COST PER TON:					
Pilotage	\$ .39	\$ .36	\$ .39	\$ .49	\$ .36
Tug Hire	.14	.15	.22	.36	.97
Line Handling	.13	.10	.04	.08	.08
Dockage	.20	.60	.78	.35	
Wharfage against ship			.50	.15	
Stevedoring, basic	7.50	6.40	6.00	5.10	4.06
Clerking and checking	3.98	3.00	2.38	.78	.37
Overtime:					
"Normal"	2.60	2.17	1.94	1.36	1.02
From sailing schedule	.76		.25	.47	.34
Total	<u>\$15.70</u>	<u>\$12.78</u>	<u>\$12.50</u>	<u>\$9.14</u>	<u>\$7.20</u>

Source: Hammer, Greene, Siler Assoc. and W. B. Saunders and Co., *The Delaware River Port* (Washington, D. C., 1965).

Other Factors. Other factors which affect a port's competitive position include: (1) its schedule of sailings, (2) congestion, (3) the availability of two way cargo flow, and (4) the freight rates between the port and the hinterland.

Some ports offer a greater selection of sailing frequencies and a wider selection of foreign destinations than others. The advantages these ports have include more direct service to foreign destinations, the immediate shipment of cargo when it gets to the port, and dependability of service. Many shippers prefer New York because it provides all of these advantages.

Port congestion can adversely affect the competitive position. It increases a ship's time in port, and it may significantly increase the cost of handling cargo. In some cases congestion has limited port growth and even contributed to the decline of a port's traffic.

The possibility for two-way cargo flow is very important to both ships and inland carriers. Ships prefer to call at a port where they can be assured of picking up a load rather than having to discharge cargo and then go to another port for a load. The same is true of truck and railroad operations. It is much more economical to transport cargo in both directions than to have to return empty. For this reason, the balance of traffic flow in a particular port is extremely important. If a port has a predominantly one-way cargo flow, it will lose potential trade to other ports whose flow of trade is more balanced.

Freight rates between the port and the hinterland are vital to a port's competitive position. These rates are set by the various inland carriers and the Interstate Commerce Commission and are usually based on volume of cargo and the possibility of two-way cargo flow.

#### The Hinterland

The hinterland, sometimes referred to as the tributary area, is basically the geographic area of land which is primarily served by a particular port. A definition of the hinterland is given by G. G. Wiegand in *Readings in Urban Geography*.

A "hinterland" can be described as organized and developed land space which is connected with a port by means of transport lines, and which receives or ships goods through the port. A port does not necessarily have exclusive claim to any part of its hinterland, and an inland area may be the hinterland of several ports.<sup>21</sup>

A study of the hinterland should include: (1) a delineation of the boundaries in order to determine the geographic area on which other studies will be based; (2) an origin and destination study of the port's cargo; and (3) an economic base study.

Delineation of the Boundaries. The limits of a port's hinterland are influenced by natural and political boundaries, by the relative costs of transporting commodities between the hinterland and the port, and by the relative strength of competing ports.

The costs of transporting commodities between the port and inland markets is the most important factor in determining the extent of the port's hinterland. These transportation costs are influenced by freight rates, subsidies to carriers, demand patterns for certain commodities, and by the adequacy of the inland transportation system.

A port actually has many different hinterlands which are determined by the various commodities it handles. For example, the Port of Jacksonville's effective hinterland for petroleum products is limited to southern Georgia, the northern part of Florida, and parts of other southeastern states. Shipments through the port for this particular hinterland have declined.<sup>22</sup> This is due to two factors: harbor improvements in competing ports enabling them to accommodate larger tanker vessels, and the increased use of pipelines. By contrast, Jacksonville's hinterland for imported automobiles has increased to include the entire southeastern United States.

Once the limits of the port's ability to attract individual commodities have been defined, a clear delineation of the various commodity hinterlands can be made. However, for the purpose of collecting data for

the port studies, an estimated linear boundary of the individual commodity hinterlands can be delineated and defined as the port's primary hinterland or main shipping area.

The hinterland will often be ambiguous and overlap other ports' primary hinterlands. This area of overlap is the area which stimulates the greatest competition between ports. The hinterland of the Port of New York is a typical example. For some commodities, the port's hinterland is the entire North American continent. Its primary hinterland is much larger than other ports which are in competition for the same trade. For example, New England is the primary hinterland for Boston; and the Ohio Valley is the primary hinterland for both Baltimore and Philadelphia. However, both New England and the Ohio Valley are part of New York's primary hinterland.

Origin and Destination Study. The economic study of the hinterland should include an origin and destination study of the main commodities shipped through the port. This study is essential to a clear understanding of the character and composition of the port's trade.

The main types of commodities, the volumes of each type and the percentage of imports and exports is important in determining the demand for facilities and methods of balancing trade flow. The origin and destination study determines the extent and diversification of foreign commodities that are shipped through the port. Some evaluation of these commodities, trends in their production and the hinterland's dependence upon them should be made. The information that is derived from the origin and destination study provides statistical data which can be used to estimate the port's growth potential and the demand for port

facilities. A balanced import and export flow of trade is a major objective of port development. Ideally, the hinterland should be both a strong consumer and producer. This encourages two-way cargo flow through the port and makes transportation and port operations more efficient.

Economic Base Study. The port depends on the economic strength of its hinterland. Without an active hinterland engaging in foreign trade, the port has no value as a service facility. Conversely, the hinterland depends on an efficient port to expedite the movement of its inbound and outbound commodities.

The economic base study should evaluate economic projections and trends. It should also evaluate the hinterland's sensitivity to national and international economic trends and the effects these might have on the port's activities. It should also provide information on the hinterland's natural resources and potential commodities which could be exported in the future as well as potential markets abroad for these exports.

The economic base study should determine which commodities represent a significant percentage of the port's total trade. These commodities should be evaluated in terms of their significance to the economy of the area and in terms of trends in their use and production. An indication of the significance of certain commodities to the port and the community is illustrated by the following example.

In 1963, the three major commodities imported through the Delaware River Ports were raw sugar, lumber, and cocoa beans.<sup>23</sup> The direct and indirect handling impacts were approximately \$4.96 per ton for raw sugar,



\$2.15 per ton for lumber, and over \$10.00 per ton for cocoa beans. Upon investigation it was found that synthetic flavoring is replacing the cocoa bean in the production of chocolate.<sup>24</sup> As a result, the importation of cocoa beans through the ports is expected to decline in the future. This could have a significant impact on the local economies and port operations.

A market analysis of the various commodities which flow through the port should be included in the economic base study. It will provide vital information on the importance of these commodities to the economy of the hinterland. It should reveal trends in the consumption of imports and potential growth in these markets. It should also investigate trends in the foreign consumption of commodities exported through the port and the potential this might have for the hinterland's production of these commodities.

### The Community

The economic prosperity of a port city depends to a great extent on the commerce generated by the port. The port's direct and indirect economic impact on the community should be evaluated.

Direct Economic Impact. Most of the direct economic impact of a port on the community is from handling, transferring, and processing cargo.

One way to estimate the port's economic impact on the community is to estimate the value added directly to the economy by a ton of cargo. General cargo adds value to the economy primarily through handling. It is expensive to handle because of its diversity and its labor requirements. By contrast, the handling of bulk cargo is mechanized, requiring

less labor. Therefore, it does not add as much value to the economy, even though it may represent a larger portion of a port's total tonnage.

In Jacksonville, it is estimated that a ton of general cargo generates \$23.81 for the local economy.<sup>25</sup> The Delaware River Port Authority estimates that the value added to the area's economy from a ton of general cargo is \$16.21, and that approximately 13 jobs are created by the handling of 1,000 tons of general cargo as compared to 1 job per 1,000 tons of bulk cargo.<sup>26</sup>

Table 2, on the following page, shows a comparison between the value added to the City of Jacksonville's economy from the movement of a ton of both types of cargo through the port.

The economic impact from processing cargo is usually more significant to an area's economy than the port's handling operations. This is especially true of bulk cargo.

Port-oriented industry tends to be a highly capitalized, high value adding industry which requires well trained, highly paid employees. Table 3, on page 42, illustrates the relative significance of the value added to Jacksonville's economy by port-oriented industry.

In Jacksonville, in 1965, the port-oriented industries represented 5,100 jobs, while the port operations employed 960.<sup>27</sup> The Delaware River Port Authority, which serves 11 counties in the Philadelphia metropolitan area, estimates that 14,000 people are employed in shipping and cargo handling, while there are 35,600 industrial employees directly dependent on the port.<sup>28</sup>

Table 2. Value Added to Jacksonville's Economy  
from a Ton of General Cargo  
Compared to Bulk Cargo

Vessel Disbursements	Income per Ton	
	General Cargo	Bulk Cargo
Port and Terminal Expenditures	.88	.21
Pilotage Tug Hire		
Docking		
Line Running		
Government Charges	.05	.02
Custom		
Surveying		
Labor	12.98	1.21
Supplies	1.86	.31
Chandler		
Doctor		
Dentist		
Laundry		
Bunkers	.02	.01
Water		
Miscellaneous	.29	.12
Port Terminal Income	2.19	
Storage and Demurrage		
Car Loading		
Rail and Freight as a pro-rated part for this area	4.06	1.35
Vessel Crew expenditures in area	.31	.08
Auxiliary Services	1.17	.11
Shipping Agents		
Freight Forwarders		
Insurance		
TOTAL AVERAGE INCOME FROM HANDLING A TON OF CARGO	<u>\$23.81</u>	\$ 4.58
Value added from processing a ton of bulk cargo		<u>12.40</u>
		<u>\$16.98</u>

Source: McFarland, Stuart W., and Weir, Norman E., *The Impact of the Port of Jacksonville on the Economy of the Community* (Jacksonville: Jacksonville University, 1965).

Table 3. Income Added to the Area's Economy  
by Processing a Ton of Cargo

Commodity	Average Revenue per Ton Added by Production
Gasoline and Oil	\$ 12.40
Coffee	260.00
Molasses	10.32
Bananas	60.00
Board and Paper	87.00
Miscellaneous Imports	24.49
Miscellaneous Exports	58.18

Source: McFarland, Stuart W., and Weir,  
Norman E., *The Impact of the Port of  
Jacksonville on the Economy of the Community*  
(Jacksonville: Jacksonville University,  
1965).

A study of the economic impact should evaluate the size and character of the labor force and its potential for expansion. The port's impact on the labor force and the implications of increased port activity should also be evaluated. This study would determine what percentage of the labor force is employed by the port and the percentage of the labor force in respective port-related activities.

The economic impact study should also investigate port-related industries to determine: their dependence on the port and on each other; their sensitivity to national and international economic trends; their dependence on foreign and domestic markets; their vulnerability to changes in technology and to consumer preferences; and their potential to expand.

Indirect Economic Impact. The port's indirect impact on the local economy results from the income and wages of port and port-related operations which are spent in the community for goods and services. These expenditures create business and the need for more jobs which in turn generate more income. The result is an economic ripple or multiplying effect on the economy.

Deriving the multiplier for a specific commodity is a highly complex process. It takes into consideration variables, such as the community's marginal propensity to consume, the amount of income spent and invested outside the community, local taxing policies, and the character of the community's economic base.

The relationship between these variables is very complex. The process for deriving the multiplier varies with each community and each set of circumstances. It should be undertaken only by a competent economic analyst.

The combined impact of direct and indirect income is generally estimated to be between two and three times the value of the primary or direct income generated by the port.

An illustrative example is the economic impact on the local economy by the Port of New York. According to the New York Port Authority, the port and related industrial and commercial operations generate approximately 430,000 jobs.<sup>29</sup> The annual income from these jobs is approximately \$2,100,000,000. The Port Authority estimates that for every dollar of income paid by the port and related activities, two extra dollars of income are generated in the community from the purchase of goods and services. The combined direct and indirect wage income

from the port generates approximately \$6,300,000,000. Thus the port's direct impact on the community is multiplied by three to arrive at the port's total impact on the local economy.

The estimated multiplier for the port of San Francisco is somewhat lower. In an economic study of the impact the port has on the city, the multiplier was estimated to be between 2 and 2-1/2.<sup>30</sup> This was due, in part, to the fact that a percentage of income is spent outside of the city in the Bay Area.

#### Transportation Studies

The port is an integral part of a complex regional and urban transportation system. A study of the transportation system is essential to the development of a port's facilities plan. It should provide an understanding of the system and its weaknesses. It should also investigate the various trends in cargo transportation and handling and the effect these trends will have on the efficient flow of cargo between the port and its hinterland.

The problems of coordinating the multiplicity of agencies, governmental jurisdictions and private interests into an efficient cargo handling system should also be considered. Historically, there has been a definite lack of coordination and cooperation between these seemingly independent interests. In 1949, Harold McLean Lewis described the problem.

Seaport cities have been slow to appreciate the need of the proper correlation, if not the unification, of rail and water terminals. They . . . have not appreciated the importance of their functions as distributing centers. Railroad terminals are often planned as if there were no other means of transpor-

tation. Shipping terminals are likewise designed as though railroad connections were of little or no importance. Only recently has the problem of port organization attracted the attention which it deserves.<sup>31</sup>

Today the transportation problem is even more acute, especially between the port and the highway connections which serve the hinterland.

The transportation study should seek new and improved methods of coordinating the planning, construction, and operation of transportation facilities. Emphasis should be placed on the elimination of duplicate facilities, the reduction of congestion, and the conservation of land for other uses. The port planning effort should be coordinated with the plans of the state, federal and local highway departments, individual railroad companies and other interests involved in planning or constructing transportation facilities.

There are three basic components of the transportation system which serve the port: (1) the regional system, (2) the urban system, and (3) the intraport system.

#### Regional System

The first step in the study of a transportation system should be an evaluation of the adequacy of transportation service to the hinterland. In order to do this, the transportation link between the port and the main cargo generators should be analyzed. Factors which might be important to the quality of service to these areas include: the variety of transportation modes available to an area; the frequency of service; and the freight rates between the specific cargo generators and the port.

The main transportation modes which comprise the regional system may include railroads, highways, inland waterways, pipelines and air service. A detailed inventory of each of these forms of transportation should be made with special emphasis on their relative importance to specific cargo generators in the hinterland and their relation to the port's operation and development. The adequacy of transportation facilities to handle the volume and type of traffic should be evaluated. Where service is deficient to a particular area, methods for improving it should be proposed. Where there are specific cargo generators in the hinterland with significant impact on the port's operation, such as mining, agriculture operations, or large metropolitan areas which import and export large amounts of cargo, their unique transportation demands should be determined and the adequacy of the facilities serving them analyzed.

Where potential markets are inaccessible to the port, the transportation study should identify these areas and recommend the necessary steps to provide them with improved transportation service to the port.

Freight rates between the port and its hinterland may be reduced by improving transportation services and facilities between the port and hinterland markets. Lower rates will increase the volume of freight flowing into the port and attract more ships bringing cargo. The possibility of two-way cargo flow is thereby increased for both ships and inland carriers.

Where alternate transportation systems are available, competition produces lower freight rates. For example, railroads reduce their rates drastically in order to compete with waterborne transportation and truck-



ing. Their speed gives them a competitive advantage over waterborne transportation.

Freight rates between the various inland markets and the port should be investigated. They should be compared with those of competing ports. If rates to competing ports are lower, the study should determine the reasons. Methods of establishing competitive rates should be determined. If the rates are favorable, methods of maintaining the port's competitive position should be found.

#### Urban System

The urban transportation system links the port to the regional transportation system serving the hinterland. The concentration of various transportation facilities serving the port has serious implications for the city. Traffic generated by the port is superimposed on the city's transportation system creating congestion, and requiring major capital expenditures for the maintenance and construction of facilities.

The transportation study should analyze the ability of the urban transportation system to accommodate existing and projected port-oriented traffic. It should identify major points of congestion and determine their effect on the movement of freight into the port area. An origin and destination study should be made of port-oriented traffic within the urban area. Concentrations of port-oriented traffic should be located and priorities for the improvement of the city's facilities assigned. Of primary concern to the urban transportation system are railroads and streets.

Railroads. The rail system's circulation patterns in the urban area and especially in the vicinity of the port should be carefully studied for deficiencies and points of congestion. Any unique problems should be given special attention.

In some cities, a circumferential rail line or "belt-line-railroad" is used to coordinate rail movements. It provides efficient service to all sections of the city with a minimum of congestion. The belt-line may also reduce harmful competition between railroad companies and eliminate duplication of facilities. If this type of facility exists in the city, its efficiency and methods of improving it should be investigated. If one does not exist, the feasibility of creating one should be investigated.

Terminal facilities and marshalling yards serving the port should be investigated to determine if they are congested or inadequate. Where facilities are inadequate, reasons for their deficiency should be determined. Where facilities can not expand, alternative locations should be sought away from the dense urban development. Marshalling yards consume large amounts of land. Where there is duplication of these facilities, consolidation should be investigated.

Streets. The city's major street system should be studied to determine deficiencies in the movement of port-oriented traffic. Congestion on the streets, especially in the vicinity of the port and on the main routes to inland highways is detrimental to the port's efficient operation.

Traffic counts of port-oriented traffic on major streets should be made. This information combined with data from the origin and

destination survey provides an understanding of the main points of congestion affecting the movement of port traffic through the city. Projections of port-oriented traffic volumes should also be made in order to provide estimates of the port's impact on streets in the future.

Two main sources of street congestion are grade crossings with railroads and bridges. Their effect on traffic serving the port should be analyzed, and recommendations should be made for alleviating congestion. Recommendations may include rerouting traffic, constructing grade separations, or bridges.

Truck terminals and storage areas are important traffic generators and have a significant impact on the street system. Routes connecting these facilities with the port should receive special attention, and methods of improving the traffic flow should be recommended. One solution might be to install one-way streets as the main carriers of truck traffic between the port and the terminals. In some instances, truck storage and terminal facilities in the vicinity of the port help alleviate street congestion.

#### Intraport Transportation

The intraport transportation system is a coordinated cargo-handling system serving port facilities. It should be adequate to efficiently handle the volume of traffic flowing into the port. It should be flexible enough to accommodate any foreseeable increase in cargo volume or change in transportation technology with a minimum of effort and expense. Problems involved in providing a coordinated system are very complex. They have been described in the following way.

The port problem is further complicated by the fact that several or all of the railroads and a number of truck lines serving a port will normally share the delivery or receipt of a vessel's cargo. All facilities at a port should be developed and operated in close coordination. At many ports of the United States this coordination is impossible because of one or more of the following conditions: . . . (3) absence of a belt line to make each wharf readily accessible to each railroad, (4) lack of adequate highway facilities including loading and unloading platforms at wharves, (5) absence of a wide marginal highway belt line along the water front reaching to all wharves, (6) lack of wide highways radiating from the port, and (7) division of responsibility for handling cargo between the ship's hold and the inland carrier. Those participating in only 100 or 200 feet of transportation often include (a) the railroad or highway carrier serving the port, (b) a carloading and unloading firm, (c) the owner of the wharf, (d) the stevedore, and (e) the ocean carrier. The result of this division in management in the operation of a set of facilities which are uncoordinated and obsolete is that vessels usually require . . . days to discharge and load cargo, and the cost of the 100 or 200 feet of transportation at the water front may exceed that of 1000 miles of transportation at sea.<sup>32</sup>

A study of intraport transportation should analyze railroads, streets, and waterways. Special attention should be given to points of congestion or inadequate facilities which impede the smooth flow of traffic through the port.

Rail facilities within the port area should be studied to determine if tracks and rail storage yards are adequate to accommodate the volume of traffic they receive. The study should determine if the rail system adequately serves the various port facilities, such as the wharves and storage areas. It should also determine if rail facilities are duplicated by competing railroad companies. This duplication consumes large amounts of land. The consolidation of rail facilities, where possible, could release land for other uses. In some cases, port agencies own and operate the port's internal railroad. This eliminates the problem of coordinating the development and operation of the rail

facilities among various private companies. The intraport railroad is owned by the port authorities in Jacksonville and Houston.

A major objective of the study should be to determine methods for reducing congestion resulting from conflicts between rail traffic and other modes of transportation, such as streets and waterways.

Motor vehicular movement and storage within the port should be analyzed. Methods of making vehicular transportation more efficient should be recommended. The street circulation pattern should be designed to provide service to the various port facilities with a minimum of conflict. A circumferential loop, serving the waterfront and inland storage facilities, or a system of one-way streets might be considered for improving traffic circulation. The system should also provide good access to the major city thoroughfares which serve the port. Problems of inadequate design of the streets should be identified. Generally, the major streets should be wide enough to accommodate two lanes of truck traffic in each direction, and the road bed should be strong enough to withstand heavy loads.

Inland waterways provide unique problems for ports. They should be studied to determine their relative importance to the port's transportation system. Conflicts with other transportation facilities should be resolved. The extent of channel congestion caused by barge traffic should be determined. Future demand for barge tie-up and storage areas should be estimated.

### Land-Use Study

A detailed land-use study of the port and the surrounding area is essential to the preparation of the port's facilities plan. This study consists of three basic steps: (1) delineation of the port area; (2) inventory of the existing uses; and (3) allocation of land for future uses.

#### Delineation of the Area

The first step in the land use study is to delineate the port area or harbor district. The area should include the port facilities and those complementary uses which require access to deep water. The area may also include the complementary uses which support the port's activities. Figure 8 shows the boundaries of the Port of Long Beach, California, and its relation to the surrounding community.

#### Land-Use Inventory

After the port area has been delineated, a detailed inventory of existing land uses and the building conditions within the area should be made. Land-use information provides a clear understanding of existing conditions in the area. It also serves as a basis for future land-use planning. It analyzes existing relationships between the various land uses, indicating any conflicts or inefficiencies resulting from poor land-use planning. Vacant land available for development is also indicated.

A detailed inventory of land uses in the port area identifies those uses which are necessary or related to port operation and those which are unrelated or detrimental to the port.

Port Facilities and Related Uses. Port facilities, as outlined

in Chapter II, and all commercial, industrial, and public functions necessary to the port's operation will generally prefer a location in the port area, and many require access to the water. These activities include:

1. Governmental and administrative agencies concerned with port development.
2. Ships chandlers which supply stores and provisions to ships.
3. Freight brokers and forwarders, including importers and exporters.
4. Wholesalers and warehousing operations.
5. Blacksmiths and machine shops which serve both ships and terminal operations.
6. Ship and marine repair services.
7. Waterfront construction operations which use floating equipment.
8. Transportation agencies and service operations.
9. Ship and barge building yards.
10. Primary metal processing industries including mills and foundries.
11. Food processing operations.
12. Petroleum refining and processing.
13. Chemical processing.
14. Lumber and paper mills.
15. Stone, sand and gravel operations.
16. Heavy machinery manufacturing operations.

Unrelated Uses. The water front attracts a wide variety of uses which are unrelated to port operations or compete with port-related uses for land. These include residences, office buildings, recreational and commercial uses. All of these land uses are attracted to the water front because it offers a unique urban setting. However, many of these uses do not necessarily need physical access to the water front. When water front property, especially with deep-water frontage, is limited, these uses compete with the port facilities and the supporting commercial and industrial activities for water front sites.

#### Land-Use Allocation

After the land-use inventory has been completed and land available for future development has been identified, it is possible to proceed with the development of a land-use plan for the port. The plan should determine what facilities and related uses are to be located in the port area, their site requirements, and their specific locations. It should assign priorities for the location and development of the specific uses. This assignment of priorities depends on the availability of land and the demand for the specific facilities. Priorities should be based on the data from the economic and transportation studies. Other factors which may be important in determining priorities include:

1. Existing land-use relationships.
2. The adequacy of present facilities and the possibility of modernizing them.
3. Projections for the growth of the port.
4. The projected demand for complementary land uses, especially port-oriented industry.



5. The site requirements of the various uses.

Figure 8 illustrates the future land-use plan for the Port of Long Beach. In addition to port facilities and related uses previously mentioned, the Port of Long Beach includes United States Naval Facilities, utilities, and commercial recreation.

The land-use plan should be flexible to insure that the proposed land-use pattern can accommodate any significant changes in the maritime industry and in the port's land-use requirements in the future. The best way to provide flexibility is to provide land for future development. This entails leaving some land vacant or in temporary use, such as for vehicular storage areas. Other methods include withholding services and facilities from certain areas until they are needed for development, and having certain areas serve multiple purposes. Allowing unrelated uses to occupy certain low-priority sites on a short-term lease basis might also be used to preserve land for future port-related uses. This would insure the future use of the site for port-related uses while providing revenue for the port until the land is needed.

The lack of flexibility in the land-use plan, without ample room for expansion, is illustrated in a report by Arthur D. Little to the Delaware River Port Authority.

An inspection of those world ports similar to the Ports of Philadelphia reveals one dominant pattern. In every case, it has been necessary to seek a large expanse of inexpensive open land which could be developed *de novo* with liberal space for piers, transit sheds, storage, processing and distribution. Examples are Swan Island in Portland, Oregon, Long Beach's outer harbor, the Gulf Waterway development in New Orleans, Dundalk in Baltimore, Port Newark, and Nieu Maas in Rotterdam. Generally it has been necessary to develop property some distance (say five to fifteen miles) from the city center. The obvious disadvantages of this are in time outweighed by the sheer necessity for space in which to work and expand.<sup>33</sup>

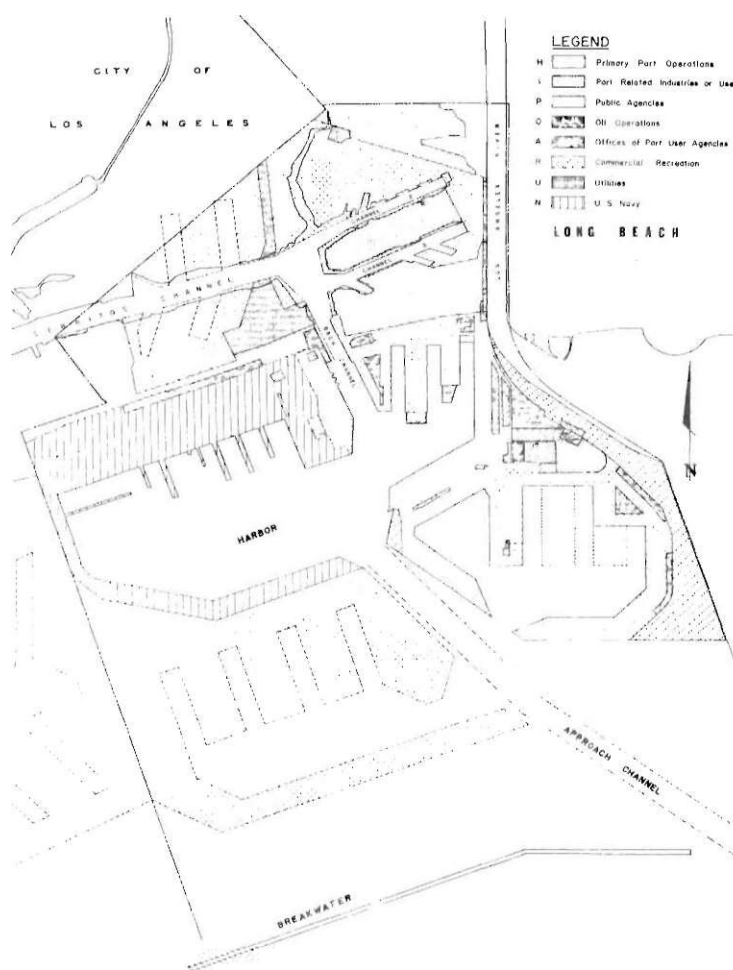


Figure 8. Port of Long Beach Future Land-Use Plan  
 Source: Port of Long Beach, Board of Harbor Commissioners, *Comprehensive Report, Volume III* (Long Beach: The Board, 1966).

Port Facilities and Related Uses. Establishing site requirements of the various port facilities simplifies the problem of allocation to some extent. Wharves and transit sheds require deep-water frontage. Transportation facilities are located in relation to various cargo-handling and storage facilities.

The location of inland storage areas is more complex. Open storage areas are inexpensive and provide flexible interim land uses. However, warehouses are relatively expensive structures, and their construction reduces the amount of land available for other purposes in the future. Warehouses generate large traffic volumes. Therefore, their location should be coordinated with the intraport and city transportation systems.

Before long-term storage facilities are proposed, accurate projections of future demands should be made. The adequacy of existing facilities in the port and community should be evaluated and the feasibility of rehabilitating obsolete structures determined.

Port-related uses have a variety of land requirements. The allocation of land for these uses does not present a major problem, except in cases where water front land is limited. The main factors in allocating land for them is to determine the specific land requirements for the various operations and to locate suitable sites. These uses often require terminal facilities with deep-water frontage for cargo handling.

Methods used to implement the allocation of land for port facilities and related uses include: (1) the establishment of bulkhead and pierhead lines, (2) the purchase of land by the port or other public

agency, and (3) zoning.

Bulkhead lines are the farthest line offshore to which a land fill or solid structure may be constructed. Open-pier construction may extend outward from the bulkhead line to a pierhead line. No construction of any kind is permitted past the pierhead line, which may or may not coincide with the limits of navigable channels set by the Corps of Engineers. These lines should be established in conjunction with the land-use plan in order to control the extent and type of development that occurs along the water front.

Most port authorities have the power of eminent domain to develop port facilities and related uses such as industrial parks. For example, the Georgia Ports Authority has acquired 388 acres and the Savannah District Authority over 900 acres for the development of port-oriented industrial sites on the Savannah River.<sup>34</sup>

A zoning ordinance, based on the future land-use plan of the port area, can be used to control future development. A zoning ordinance can designate special port districts listing uses to be permitted in the port area (see the Appendix for sections of the Miami and the Long Beach ordinances) or it may use performance standards. An example of a performance standard is the requirement in Detroit, Michigan, that industries locating on the water front demonstrate a need for at least 1,000,000 gallons of water per day as either a raw material or a coolant.<sup>35</sup> Other performance standards require industries to demonstrate a dependence on access to water transportation.

Unrelated Uses. Information from the land-use inventory indicates the extent and condition of uses which are unrelated to the port. This

information can be used to determine the desirability and feasibility of relocating these uses outside the port area. If there is an abundance of land in the area, and if these uses present no major problem for the port, their relocation may not be necessary. However, if there is a scarcity of water front land, or if certain uses cause interference with port operations, a plan for their relocation should be formulated.

Urban renewal can be used to replace unrelated uses with port facilities or related uses. Urban renewal of water front areas incorporating port facilities in the new plan has been successfully accomplished in many cities, including Boston and Gloucester, Massachusetts; Port Hueneme, California; Jersey City, New Jersey; and Norfolk, Virginia.<sup>36</sup>

In other cases, port authorities have directly acquired unrelated uses, without Federal Urban Renewal funds, and redeveloped the land themselves or sold it to private developers to be used for port-related purposes. The redevelopment of land for port-related uses has been upheld in the courts as a public purpose and a reasonable use of eminent domain.

In the case of *Sublett v. City of Tulsa*, 405 P. 2d 185, May, 1965, the court ruled that the City of Tulsa could acquire property to develop a port and industrial park, even though such facilities would be leased to private companies. The court stated that industrial development proposals were for public rather than private purposes.

In the case of *Hogue v. Port of Seattle*, 54 Wash. (2d) 799, 341 P (2d) 171, the Court reasoned that the basis for acquiring agricultural and residential land by eminent domain rested on the fact that the port

could devote it to what it considered a higher and better economic use, in this case, to sell it as industrial sites.

In the case of *Lerch v. Maryland Port Authority*, 214, A. 2d 761, Nov., 1965, the Court decided that the Maryland Port Authority could acquire land for the construction of an international trade center in the Port of Baltimore. The Court reasoned that this action was a public purpose because it would promote the economic well-being of the state.

#### Engineering and Site Studies

Before plans for the location of the port's facilities can be finalized and certainly before construction of the facilities begins, detailed information on the site should be obtained. This information should include: (1) a hydrographic survey of the harbor and channel; (2) a topographic survey of the proposed area for development; and (3) a soil study investigating substrata conditions. Other useful information might include data on climatic conditions, earthquakes, harbor pollution and the availability of construction materials.

In many cases, this data will be available from previous studies. However, existing data should be updated with special studies designed to provide information useful to the current planning and development program.

#### Hydrographic Survey

An understanding of hydrographic conditions is essential to the design and construction of structures having contact with the water. It is important to any underwater operations such as dredging and fill-

ing. The survey should provide information on the condition and character of the harbor bottom. The depth of the harbor and the slope are important factors in the design of port facilities. The study will also provide information on the strength of currents, fluctuation in tides, and wave action.

Much of the information can be obtained from marine navigational charts. Another source is the U. S. Corps of Engineers which is responsible for the maintenance and improvement of all channels and harbors.

#### Topographic Survey

A topographic survey of the shore area on which proposed facilities are to be built should be made. This study provides information on the contours of the land and any problems that might be encountered in constructing facilities. This information can be obtained from U. S. Coast and Geodetic Survey maps, from U. S. Department of Interior Geological Survey Maps, and from site inspection.

#### Subsurface Survey

An investigation of the subsurface and rock conditions of both the harbor and the shore area is essential to the design of the port's facilities. This study provides a profile of the soils in the area. It gives design engineers information on the load-bearing characteristics of the soils, the presence and extent of ground water, and the cost and feasibility of dredging. Background information can be obtained from the U. S. Geological Survey and the U. S. Department of Agriculture. If more detailed information is required, a detailed site investigation should be conducted.

### Miscellaneous Surveys

Ports are frequently located in areas subjected to hurricanes, typhoons, earthquakes, hard freezes, and other severe weather conditions. Detailed information on the frequency and intensity of such occurrences is important to the design of the port's structures. Much of this information can be obtained from the U. S. Weather Bureau, the U. S. Coast Guard's records, and from observations and tests.

Other factors having a bearing on the location and construction of facilities include the availability of materials, such as stone for breakwaters, and soils for fill; the extent of harbor pollution; and the availability of utilities and services.

### Organizational Studies

Before the port's development plan can be implemented, there must be a responsible agency capable of handling the project. If there is an agency responsible for port development, the scope of its authority and its ability to develop the port should be evaluated. If there is no existing agency capable of port development, one should be organized.

The principal types of agencies engaging in port development are governmental departments and independent agencies. Independent agencies are both regulatory commissions and public corporations. A port development agency may have interstate, state, regional or local jurisdiction. The preference of one type of agency over another depends on factors, such as the size of the port, the magnitude of the proposed development, the port's relation to other ports in the area, and the unique political, financial, and legal characteristics of the particular area.



In order to determine the organizational structure and jurisdictional limits of an appropriate agency, certain studies should be conducted. These studies include a determination and evaluation of problems resulting from: (1) intergovernmental relations; (2) political conditions; (3) financial inadequacies; (4) personnel policies; and (5) legal restrictions.

#### Intergovernmental Relations

A study should be made to determine the extent of problems which are caused by the fragmentation and duplication of governmental agencies in the area. The boundaries of the port area may not coincide with the various municipal, county and state boundaries. Many different agencies and private interests within the metropolitan area may be responsible for the development of the port. This multiplicity of governmental jurisdictions can result in complicated problems which may dictate the organizational structure of the agency that must be used if a port development program is to be successful. This study should determine how many agencies are involved in port development, the extent of their involvement, and their particular interest in the port. It should also make an evaluation of the relationship between these agencies. Any inter-agency conflicts or problems which might hinder port development should be considered.

A department of the local government, such as a "Department of Ports" or the Public Works Department, might be able to efficiently implement the plan if the proposed development is entirely within its jurisdiction, and if there are no inter-agency conflicts. Port development and operation, as a department of local government, has been

successful in Long Beach, California, Anchorage Alaska, Richmond, Virginia, and many others. The main advantages of the governmental department include: (1) its ability to implement the policy decisions of the chief executive, (2) its close liaison with other governmental departments, and (3) the relative ease with which it can be created.

An independent commission as a regulatory body might be organized if there is extensive private terminal development in the area. It could control and coordinate the efforts of various private and public interests. Its powers are usually limited to persuasive and coordinative efforts, with little or no ability to engage in port development itself.

The independent public corporation has proven to be an effective organization for dealing with intergovernmental problems, such as port development in urban areas. It can carry out its functions unrestricted by the boundaries of governmental jurisdictions. Other advantages include: (1) its singleness of purpose, permitting it to implement plans more efficiently; (2) its relatively uncontroversial nature; and (3) its autonomy.

An example of a public corporation is the Port of New York Authority which involves an interstate compact between New York and New Jersey. The compact provides that:

The Port Authority shall constitute a body both corporate and politic with full power and authority . . . to purchase, construct, lease and/or operate any terminal or transportation facility within said [port] district; and to make charges for the use thereof . . . and for any such purpose to own, hold, lease and/or operate real or personal property, to borrow money and secure the same by bonds or by mortgages upon any property held or to be held by it.<sup>37</sup>

The New York Port Authority has proven to be an effective organization for developing port facilities in a complex, bi-state, metropolitan area.

The Delaware River Port Authority and the Harris County-Houston Ship Channel Navigation District are also public corporations, formed to overcome intergovernmental and jurisdictional problems in developing port facilities.

#### Political Considerations

The feasibility of organizing an agency to develop the port may be influenced by the political situation in the community. The effect of politics on the agency's ability to implement the plan should be evaluated. If it is determined that the port's development is hindered because of partisan politics or an unsound political structure, the study should determine methods of removing port development from the influence of politics and putting it on a more business-like basis.

Due to its inherent apolitical nature, the public corporation may be the only type of organization that can function effectively in a particular political situation. In most states a public corporation can be created by an act of the legislature without a referendum. Its operation is quite similar to a private business corporation, and partisan politics may have little or no influence on its activities.

One criticism of the public corporation is its autonomy. Its critics argue that because it is autonomous and relatively free to engage in a specialized activity, it adds to the fragmentation of jurisdictional authority in the metropolitan area. This, however, does not limit its ability to accomplish a specific goal, such as port

development.

An analysis of the political "climate" might provide information on the feasibility of financing and implementing the development program. It might also indicate the necessity and feasibility of passing enabling legislation in order to organize the type of agency desired.

#### Financial Considerations

The financial soundness of the various agencies and their ability to incur further debt in order to implement a port plan should be investigated. In some cases the debt limit of existing agencies may not be sufficient or provide the necessary financing or it may be politically unfeasible to raise taxes to finance port development. Where these or other financial complications exist, the organization of a public corporation might be the only solution. The public corporation is not hindered by the financial restrictions that are placed on local governments. Its financial powers are more flexible. It can sell bonds, incur debt, and utilize user charges. In some cases it can levy taxes and special assessments. The public corporation normally is not hindered by debt limitations. In some states public corporations are eligible for grants from the Federal and State governments not available to governmental agencies.<sup>38</sup>

#### Personnel Policies

The successful development of the port is dependent on qualified personnel. The agency must compete with private and public agencies in order to recruit qualified individuals. Inadequate, obsolete civil service regulations, low salaries, and political insecurity may prohibit the attraction of qualified people.

Personnel and civil service regulations of agencies should be analyzed. If the port's development is hindered by an agency's inability to recruit adequate personnel, restrictive policies should be eliminated. If this is not feasible, an organization which can perform these functions more efficiently should be adopted.

A public corporation is potentially an efficient organization for recruiting and managing personnel. It is not restricted by the civil service regulations of local governments. Its management is usually more professional and efficient. Its employees are protected from politics, and it frequently can pay higher salaries than governmental agencies.

#### Legal Considerations

After studies have been made to determine what type of agency would most efficiently implement the plan, state constitutional and statutory restrictions should be analyzed to determine what legal steps are necessary. The study should review existing legislation and recommend the appropriate legal procedures to create the appropriate agency. In many cases enabling legislation will be required.

A port is an exceedingly valuable asset to a community. Its physical and economic value can be greatly enhanced by careful planning which takes into account all the many interrelated factors which affect the port and its relation to the community.

The port's development should not be haphazard and without direction, but, rather it should be preceded by basic studies which identify its relation to the community and the problems which must be overcome if the port is to be effective. If the studies proposed in

this thesis are made as an integral part of the port's planning program, a basic understanding of the port's relation to the community as well as the necessary steps to improve it should be reached. After a plan is completed, the development of the port should proceed in an orderly manner with maximum efficiency.

## APPENDIX

## APPENDIX A

## PORT-ORIENTED ZONING PROVISIONS

## MIAMI, FLORIDA ZONING ORDINANCE

## ARTICLE XIX, WATERFRONT INDUSTRIAL, W-1 DISTRICT

## Section 1

## Use Regulations

No building or structure or part thereof shall be erected, altered, or used, or land or water used, in whole or in part, for other than one or more of the following specified uses in accordance with the limitations hereafter specified:

- (1) Ship yards, dry dock, marine railway.
- (2) Ships, yachts and boat storage.
- (3) Commercial docks, wharves, and piers, marine warehouse, freight storage shed, freight handling equipment.
- (4) Boat and ship building and repairing.
- (5) Marine shop, woodworking shop, electrical shop, and similar uses for construction, repair, and maintenance of boats.
- (6) Railroad lines and sidings to service wharves and piers.
- (7) Dredging base, marine construction yard, marine salvage base.
- (8) Fish house, fish canning, smoking and curing.
- (9) Ship chandlery, sail maker.
- (10) Manufacture of boat parts, accessories and equipment, not involving drop-forging, stamping, automatic screw machines, or a foundry.
- (11) Railroad right-of-way, freight terminals, team-tracks, spur-tracks.
- (12) Boat sales, service and rentals.



- (12-A) The following USES if approved as "Conditional Uses":
  - (a) Docks and piers extending into Biscayne Bay a distance greater than twenty-five (25) feet beyond the Dade County Bulkhead line subject to the limitation and conditions prescribed by Section 23 of ARTICLE IV.
- (13) Accessory uses and structures including one (1) dwelling unit accessory to a permitted structure.
- (14) Other uses: Other uses or enterprises, similar to the above, which in the judgment of the Zoning Supervisor of the Building Department, are similar to and not more objectionable to the general welfare than the USES listed. "OTHER USES" so determined shall be regarded as "LISTED USES." In no instance, however, shall the Zoning Supervisor determine nor the regulations be so interpreted that a USE shall be permitted in a District when such use is specifically listed as first permissible in a less restricted District.

APPENDIX B

ZONING PROVISIONS FOR THE PORT  
OF LONG BEACH, CALIFORNIA<sup>39</sup>

The harbor district of the Port of Long Beach is divided into "sub-zones" which permit industrial and commercial uses but excludes residential uses. The Port Authority uses a "sub-zone" map which is reproduced in this thesis as Figure 8, as an aid to planning and development. This map generally delineates the areas that the port sets aside for specific usage. Following is a description of these sub-zones.

Sub-Zone "H". "Primary Port Operations" designates areas reserved for shiploading facilities, transshipment warehouses, stevedoring operations, and industrial operations primarily engaged in the shipment of goods and raw materials.

Sub-Zone "I". "Port-Related Industries or Uses" designates areas reserved for ship chandlers, sail lofts, marine architects, boat sales, and manufacturing and processing operations whose products or raw materials normally move through the Port.

Sub-Zone "P". "Public Agencies" designates areas reserved for Harbor Department administration and maintenance facilities, Coast Guard offices, and other government institutions.

Sub-Zone "O". "Oil Operations" designates major areas reserved for oil production, storage and processing plants, drilling sites, and injection wells. Minor installations and single wells may be placed in other zones except in Zones "A", "P", and "U".

Sub-Zone "A". "Offices of Port-User Agencies" designates areas reserved for main offices of shipping companies, commercial fisheries, customs brokers, and other Port users. Excluded from this area are all storage yards, gear sheds, warehouses, and equipment garages.

Sub-Zone "R". "Commercial Recreation" designates areas reserved for facilities such as boatels, trade fairs, ships, and privately

operated aquariums and museums. Charter boat operations, sport-fishing, and tackle shops are also included in this zone.

Sub-Zone "U". "Utilities" designates areas reserved for surface installations and rights-of-way of public utilities.

Sub-Zone "N". "U. S. Navy" designates areas permanently occupied by the U. S. Navy.

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